*November* 19, 1868.

Lieut.-General SABINE, President, in the Chair.

In pursuance of the Statutes, notice of the ensuing Anniversary Meeting for the Election of Council and Officers was given from the Chair.

Mr. Currey, Mr. Hudson, Mr. Newmarch, Mr. Prestwich, and Mr. Stainton, having been nominated by the President, were elected by ballot Auditors of the Treasurer's Accounts on the part of the Society.

Dr. Bastian, Rear-Admiral Cooper Key, and Mr. Vernon Harcourt were admitted into the Society.

The following communications were read :—

"On the Physical Constitution of the Sun and Stars." By G. JOHNSTONE STONEY, M.A., F.R.S., F.R.A.S., Secretary to the Queen's University in Ireland. Received May 15, 1867. (See page 1.)

I. "Second List of Nebulæ and Clusters observed at Bangalore with the Royal Society's Spectroscope;" preceded by a Letter to Professor G. G. Stokes. By Lieut. JOHN HERSCHEL, R.E. Communicated by Prof. STOKES. Received July 20, 1868. (See page 58.)

II. "On the Lightning Spectrum." By Lieut. JOHN HERSCHEL, R.E. Communicated by Prof. STOKES. Received August 8, 1868. (See page 61.)

III. "Products of the Destructive Distillation of the Sulphobenzolates."—No. II. By JOHN STENHOUSE, LL.D., F.R.S., &c. Received September 8, 1868. (See page 62.)

IV. "Compounds Isomeric with the Sulphocyanic Ethers.—II. Homologues and Analogues of Ethylic Mustard-oil." By A. W. HOFMANN, Ph.D., M.D., LL.D. Received September 11, 1868. (See page 67.)

V. "Account of Spectroscopic Observations of the Eclipse of the Sun, August 18, 1868." In a Letter addressed to the President of the Royal Society by Captain C. T. HAIG, R.E. Communicated by the President. Received September 21, 1868. (See page 74.)

VI. "Account of Observations of the Total Eclipse of the Sun, made August 18th, 1868, along the coast of Borneo." In a Letter addressed to H.M. Secretary of State for Foreign Affairs, by His Excellency J. POPE HENNESSY, Governor of Labuan. Com-

municated by the Right Hon. Lord STANLEY, F.R.S. Received October 8, 1868. (See page 81.)

VII. "Further Particulars of the Swedish Arctic Expedition." In a Letter addressed to the President, by Professor NORDENSKIÖLD. Communicated by the President. Received October 15, 1868. (See page 91.)

VIII. "Notice of an Observation of the Spectrum of a Solar Prominence." By J. N. LOCKYER, Esq., in a Letter to the Secretary. Communicated by Dr. SHARPEY. Received October 21, 1868. (See page 91.)

IX. "On a New Series of Chemical Reactions produced by Light." By JOHN TYNDALL, LL.D., F.R.S., &c. Received October 24, 1868. (See page 92.)

X. "Account of the Solar Eclipse of 1868, as seen at Jamkandi in the Bombay Presidency." By Lieut. J. HERSCHEL, R.E. Communicated by Prof. G. G. STOKES, Sec. R.S. Received October 19, 1868.

*To the President, Council, and Fellows of the Royal Society.*

GENTLEMEN,—The time has arrived when I must offer for your acceptance a connected report of the employment of the instruments intrusted to me for the special purpose of observing the late solar eclipse.

1. *Plan of this Report.*

In framing this Report I propose in the first place to describe those instruments sufficiently in detail to render unnecessary such explanations as would otherwise be required in the course of my narrative, and then to show the circumstances which preceded their actual employment on that occasion.

2. *Description of Telescope and clockwork.*

The principal instrument is an equatorially mounted telescope, with a lens of 5 inches aperture and 62 inches focal length. The mounting is adapted to any latitude (except very low and very high ones), the polar axis being a moveable tangent to the circular-arched roof of the chamber containing the clockwork. The latter, as well as the rest of the instrument, is by Messrs. Cooke and Sons, of York, and is, as I understood from Mr. Cooke, of a somewhat novel description. I have not examined the mechanism closely, and therefore cannot describe it very accurately; but I believe the peculiarity consists in the maintenance of continuous motion in a fan-wheel, regulated by a pendulum time-keeper acted on through a remontoir escapement, whereby the irregularity of the surplus energy of the driving-weight, while it is prevented by the latter from interfering with the time-keeper at all, is modified in its action on the tube by the former. The *mean* rate of motion is

thus uniform; and though there is very perceptible irregularity in the *actual* motion, it is not intermittent. Thus, when the image of a star, for instance, is brought on the slit of the spectrum-apparatus, the spectrum is fitful in appearance, if the slit is perpendicular to the direction of diurnal motion. The mean motion may be easily regulated as in a pendulum-clock. The motion is communicated by friction to the first of a series of wheels which terminates in an endless screw working in the circumference of a large toothed arc attached to the hour-axis. Motion imparted by hand to one of these wheels, grooved and provided for this purpose with an endless cord, is thus communicated directly to the tube without greater strain on the clock than is implied in overcoming the connecting friction.

### 3. *Its Mounting.*

The declination-axis terminates in a T-shaped head carrying two circular collars, in which the telescope-tube rests. For convenience in mounting and dismounting, these collars are attached to the T-head by nut and pins, so that they lift off with the tube, while the balance can be adjusted by releasing their grasp of the tube when required. This is a great convenience in a portable instrument. The tube can be dismounted and taken indoors readily without assistance; and the body of the instrument (which, besides being far less easily handled, has cost hours of adjustment) may be left under a suitable waterproof case when no observatory has been constructed.

### 4. *Its Stand.*

The stand is a strong wooden one, of remarkably firm construction, considering that it is of the three-legged portable kind. Its upper surface is a stout brass annulus, on which the clock-chamber rests and rotates, if required, for adjustment in azimuth. Two of the legs have foot-screws for adjusting the level and completing the adjustment for latitude.

### 5. *Of the Spectroscope.*

The spectroscope intended for use with the above telescope was constructed by Messrs. Simms, on a pattern or design supplied (I believe) by Mr. Huggins; but its construction was too much delayed to allow of a practical examination of all its parts before packing. It consists of a single flint-glass prism, of refracting angle 60°, contained in a cylindrical brass chamber, from which radiate three tubes in such directions as to fulfil the several purposes of (1) receiving the light to be analyzed, (2) delivering it after refraction and separation to the eye, and (3) admitting external light for reflection to the eye off the second surface of the prism. The first consists externally of a long connecting tube for insertion into the telescope in place of the ordinary eye-tube, where it is grasped in the focusing-slide. Internally it carries a smaller tube, carrying at one end a lens, and at the other, at the principal focal distance of the latter, a beautiful piece of workmanship by which a slit is obtained whose sides

approach each other equally. Half the length of this slit may be obscured by the intervention of a right-angled prism, which reflects a side light through it if required. The converging rays from the object-glass falling on the slit are admitted, while those which do not are stopped. The former diverging again, as though from a luminous line, emerge from the next lens and fall on the prism as parallel rays, are independently refracted and dispersed in traversing it, and after emergence are again condensed, but not reunited, by the object-glass in the small telescope composing the second of the above-mentioned tubes, and, forming a spectrum in its focus, are viewed as such by an eyepiece.

*Means of measurement.*—The direction of emergence defines the position in the spectrum; and the difference of direction is measured by the change of direction of the small telescope necessary to receive the several refracted rays directly. This change of direction is effected and measured by a tangent screw, whose complete revolutions are indicated by the march of a graduated scale (attached to the telescope-arm) over a circle marked on the circumference of the divided cylindrical head of the screw. The position of the centre of motion of the telescope-arms, it should be said, though optically unimportant, is practically within the prism. By the help of a reading-lens the revolutions, and tenths and hundredths of a revolution, can be easily read off by a very slight movement of the eye from the eyepiece.

*New graduated Scale for micrometer measures.*—A mistake having occurred in graduating the scale, I substituted one of my own making. As I was fortunate in this, I may venture to describe how it was effected. The graduation required was too fine for any ink lines I could make; I therefore varnished a piece of card, and drew fine lines at the proper intervals on the shellac-coating with a sharp blade; and applying a little ink, these were instantly rendered visible. I then cut the card across the lines and glued the scale so formed over the old one with varnish, giving the whole a dash of varnish for the sake of protection. When dry I was gratified to find the graduation correspond well with the revolutions; for it was rather a delicate job, and I did not succeed without failures.

### 6. *Graduated Scale in the Field of View.*

The third tube was intended to present in the field of view of the telescope last described, by external reflection off the second surface of the prism, an illuminated image of a photographed scale placed at one end of the tube, in the principal focus of a lens at the other. The tube carries a small moveable mirror outside. Upon this mirror was intended to be thrown the light of a small lamp, held n position by a bent arm projecting from the prism-chamber. I am sorry to say that this ingenious contrivance proved, in my hands, more unsatisfactory than perhaps it should have done. As in *not* using it I departed from the letter of my instructions, I am in a measure bound to explain my reasons for discarding it.

*Reasons for discarding it.*—In the first place, I never could with any kind of illumination train my eye to read the scale, partly because (whether from diffraction or irradiation) the image was never distinct, partly because the figures were illegible. In the next place the little lamp was capricious; either it refused to keep alight, or it boiled its own oil and melted off its handles, and ended by burning my fingers! Thirdly, it was an additional weight at the eye-end of the telescope and involved a counterpoise when not in use, and an additional projection to be avoided in every movement —in the dark,—all implying additional distractions and sources of failure. Lastly, I found I could do very well without it—in the preliminary training which I underwent on examining the nebulæ. At the same time I must confess that I made an oversight in trusting too much to the illuminating power of a hand-lamp, as will be apparent when I come to describe the actual eclipse-observations.

### 7. *Smaller Telescopes and Polarizers.*

The second instrument supplied was an achromatic refractor of 3 inches aperture mounted with vertical and horizontal axes, the socket of the former being supported on a three-legged wooden stand, afterwards replaced by one of greater stability and more convenient height. Two cells, containing a double-image prism and quartz plate, and the combination known as Savart's polariscope, respectively, were supplied for use with this telescope, but without any connecting adaptation.

### 8. *Hand Spectroscopes.*

The other instruments were hand spectroscopes for direct vision, four in number, which I was directed to distribute according to circumstances. It is needless to describe these instruments, as they are well known; but I must venture to correct a statement made at a meeting of the Royal Asiatic Society last December, that they have a magnifying-power of 8 or 10. I do n't think they can be credited with a higher power than 3; and I was never able to recognize any of the peculiar characteristics of nebular or stellar spectra, the recognition of which might have been expected with the higher magnifying-power.

### 9. *Arrival in India and communication with Colonel Walker, R.E.*

Soon after my arrival in India I communicated with Colonel Walker, with the object of receiving his instructions and of ascertaining whether he had decided on any plan, and, if not, to learn his views with reference to the assistance I might expect from the Survey Establishment. The choice of a station of observation and the disposal of the instruments were also discussed in the course of correspondence.

### 10. *His Reply, and application to the Indian Government.*

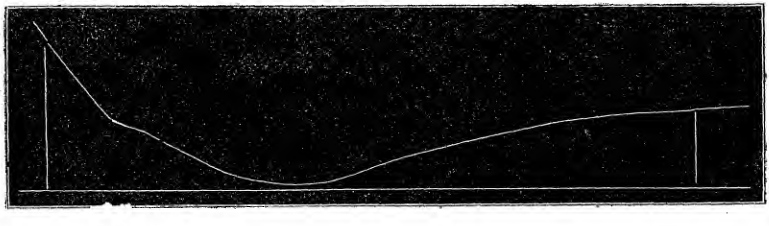
Colonel Walker's action in this matter has been most gratifying. He immediately promised me the assistance of Lieut. W. Maxwell Campbell,

of the Bombay Engineers, one of the executive officers of our Department, at that time engaged with myself and others in measuring a base-line in the neighbourhood of Bangalore, for the polarization-observations or otherwise, as I might arrange with him. He also placed at my future disposal for the occasion the services of Lieut. Campbell's assistants, in case such should be required, at the same time presenting to the Indian Government an urgent proposal to give the Royal Society's expedition both countenance and support. I enclose a copy of the reply to this proposal, in which it will be observed that the Governor General in Council "cordially approves," and "sanctions the necessary expenditure," and pledges the Government "to do everything in its power towards securing full and accurate observations" on the occasion—a pledge fully redeemed by the ready assent given to more than one other application. I am accordingly enabled to submit to your Society my present Report unaccompanied by any further appeal to your Treasurer.

11. *Steps taken to procure local information as to weather &c.*

The local Governments were also applied to to give effect to the circulation of a series of queries calculated to elicit local information as to probable climate at numerous points situated along the line of shadow. This was the more necessary, as my position at Bangalore (in the very centre of the peninsula) seemed to give a so much greater range of choice. In this respect also a warm interest was evinced. I wish I could add that the mass of correspondence which resulted was productive of an equal amount of valuable information. The practical value was chiefly confined to extracts from rain-registers, the principal question relating to probable cloudiness or otherwise being perhaps necessarily replied to too vaguely to form legitimate grounds for decision, owing in great measure to the fact that August is one of the most uncertain months in the year, in that respect, in southern India.

*Rough notion of rain distribution across the peninsula in August.*—On the whole, however, it appeared that across the whole width of the peninsula cloudy weather was to be expected at that season; and there was therefore no choice but what could be based on rainfall. The annexed diagram represents the impression (necessarily a vague one) remaining on



my mind after considering the reports. On the west coast anything up to 25 inches *a week* has been recorded in August; on the eastern slopes of

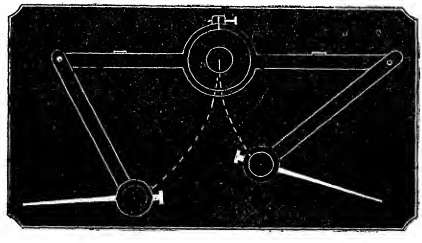
the western Ghauts the fall seems both smaller and more regular, 6 to 10 inches being the usual fall in the month of August. Further inland we come to a tract notorious for its dryness, several places, such as Gokāk, Jamkandi, Bējápúr, and others thereabouts, being favoured with occasional showers only. I attributed this to the descent into a lower and hotter region of the prevailing south-west current, the greater part of whose moisture had been deposited during the disturbance of strata caused by passing over the sudden barrier of the Ghauts. Beyond this again, eastwards, there is a gradual rise in the amount due in August, until towards the east coast the average fall is again 6 or 8 inches.

12. *Jamkandi selected.*

Jamkandi, the residence of a native chief, was among the first to attract my attention, partly owing to the offers of assistance which were made in the name of the chief; and this place was eventually selected for the advantages of climate which it appeared to offer.

13. *Distribution of the Instruments. Lieut. Campbell, R.E.*

In the meantime the distribution of the instruments was attended to. The smaller telescope with polarizing eyepieces was made over to Lieut. Campbell with a copy of the "Instructions," in the full assurance that he would acquaint himself with the theory and practice necessary to turn them to account. I annex a copy of his Report, the perusal of which will show that the instrument was in good hands. It is much to be regretted that he was not permitted to give more practical evidence of the forethought which characterized his preparations. I am also sorry that he has not given a fuller description of the ingenious contrivance which he designed and constructed for the ready application of the analyzers to the eyepiece. The annexed rough sketch (from memory) may help to give a correct idea of the contrivance.



I apprehend that in the event of fair weather he would be able to settle the question of polarity readily, and would have leisure to make use of a hand spectroscope as well. One of these instruments also was therefore made over to him.

14. *Captain Haig, R.E.*

Colonel Walker had further consented to allow another of our executive officers (Captain Haig, R.E.) to leave his regular duties for a time if he wished. As he was stationed at Poona and could avail himself of the railway as far as the border of the shadow's path, I offered him, and he accepted, the charge of another of the hand spectroscopes.

15. *Peninsular and Oriental Steam Navigation Company's Agent, Captain Henry, Superintendent at Bombay.*

Lastly, I communicated with the agents of the Peninsular and Oriental Company at Calcutta and Madras Bay, and eventually intrusted the remaining two spectroscopes to the latter for employment on board two vessels, outward- and homeward-bound, which would probably be on the track at the right time.

16. *Memorandum of explanations and suggestions for use of Hand Spectroscopes.*

It was necessary, however, not only to distribute these instruments, but also to provide for their being intelligently employed in unpractised hands. I accordingly drew up a short memorandum with the object of putting it into the power of those interested to understand as much of the subject as seemed necessary, and of suggesting the probable appearances which might be presented. A copy of the pamphlet accompanies this Report.

17. *Examination of Nebulæ as bearing on the main subject.*

While these arrangements were in progress I was myself engaged with the equatorial in the examination of the southern nebulæ, to which I devoted as much time as the duties of my profession enabled me to do. The weather was very favourable in March (towards the middle of which month the base-line was completed), in April, and until the middle of May; but from that time until the latter end of June, when the instrument had to be despatched, I hardly got a single observation, owing to the setting-in of the south-west monsoon. I congratulated myself on having been able to use the fine nights we had had. The results, showing the nature of the spectra of about fifty nebulæ, have been already communicated to your Secretary; there is therefore no occasion to enter into particulars on this subject here, except as bearing on instrumental peculiarities not previously touched upon, and as suggesting the probability that a considerable familiarity with the special kind of observation had been acquired, as well as with the individual instrument. Those who are acquainted with the spectroscope as applied to a telescope will remember that it involves several additional screws to be attended to, and that the finding of these mechanically in the dark is no inconsiderable perplexity until habit has taught the way. But this by the way.

18. *The Finder, and the trouble it gave.*

The finder attached to the telescope has a very low magnifying-power and decidedly bad definition—so much so that even Saturn can scarcely be recognized with it; none but the most conspicuous nebulæ and clusters are visible; I have looked in vain for the planetary nebula in Lyra with it, though it was certainly in the field; and of all the planetary nebulæ in the southern hemisphere, only two (Nos. 2102 & 4510) are noted by me as

"visible in finder." It was therefore almost always necessary to *find* with the principal, by the setting; and afterwards either to exchange the light eyepiece for the heavy spectroscope (removing at the same time a counterpoise) without disturbing the direction, if possible, or to take the bearings of the most conspicuous stars visible in the finder. But as there never was and never could be any certainty that in the act of insertion a disturbance sufficient to displace the image from the position the slit should occupy would not take place, the latter method became the surest, if the most troublesome. [The connecting-tube, I should remark, cost me, literally, days of worry and grinding before I could induce it to slide in and out at all.] If after these precautions the result of a blind search was negative, the whole had to be done *de novo*. What with removing and replacing the spectroscope, inserting eyepieces and counterpoises, setting the readings, searching in both finder and telescope, winding the driving-clock over and over again, in endless combination, all by the light of a bull's-eye lantern, perhaps without catching a single spectrum all night, I often found four or five hours' observing (?) more fatiguing than a long walk.

It may appear strange that I did not replace the finder by a better telescope. I can only say that India is not England, and Bangalore is not London. The idea did not occur to me as a practical one, and I was nervously afraid of making any alteration which *might* leave me worse off than I was. A bad finder was after all no great matter, for the eclipse and the nebulæ could wait. At the same time I wish now that my finder *had* been more serviceable as a telescope for I got; but a poor sight of the eclipse with it.

### 19. *Further preparations, Observatory, &c.*

To return to my preparations. In the utter absence of any precise knowledge of the appearances which would be presented, but anticipating a faint spectrum as the most probable, all my preliminary arrangements had in view as complete an exclusion of external light as practicable. A wooden frame was constructed for an observatory with a revolving roof, the latter being covered with painted canvas. A large black curtain was provided, through the centre of which were to be passed the observing-end of the telescope and finder, and the declination-clamp and slow-motion screw. A segment of the octagonal observing-chamber would thus be in a great measure protected from the light which might be expected to enter the limited aperture in the roof.

### 20. *The Expedition leaves Bangalore.*

The instruments, observatory, and camp-equipage started from Bangalore on the 7th of July, and reached on the 7th of August—a creditable march of 390 miles in 31 days (including halts) in the height of the rainy season. My subsequent experience of the state to which so-called "made" roads may be reduced, in these parts of India, by a few days' rain, afforded grounds

for self-congratulation that the journey was accomplished as quickly as it was. I followed on the 1st of August, and reached Jamkandi on the morning of the 14th. The journey was so exceedingly disagreeable a one that I shall say no more about it.

21. *Arrival at Jamkandi.*

By the evening of the 14th the observatory was put together and the telescope &c. ready for adjustment.

22. *Prospects.*

I was surprised and considerably disappointed to learn that the weather had been for some days past as cloudy as I found it. I had left heavy rain behind me at Belgaum, and found none at Jamkandi certainly; but the sky was thick with passing cloud. I was told that it was quite unusual, and that it could not last; but by the morning of the 18th both Lieut. Campbell and myself had made up our minds not to be disappointed (if we could help it), should we be denied more than a few glimpses.

23. *Bad weather not unusual at this season.*

I learned afterwards that at some time or other at that season a burst usually takes place on the Ghauts, causing a sudden and violent flood in all the rivers, and that the influence of this extends beyond their limits and occasions the fortnight of cloudy skies and scanty rainfall which such places as Jamkandi enjoy once a year. This periodical flood had occurred between the time of our camp's and our own arrival, and we were now experiencing the cloudy season. It was very unfortunate, but could hardly have been foreseen. Not only our own party, but others in the neighbouring district of Béjápúr were unlucky. Three days later the whole aspect of the country was changed. The rivers subsided; the heat which we had expected, but missed, began to make itself felt; the villanous black soil hardened; and the natives said confidently that their rainy season was past, and that the rivers would not rise again till next year.

24. *Lieut. Campbell's Station.*

On the 17th Lieut. Campbell selected his position on a hill about a mile distant. We had agreed that the character of the clouds was such that a greater separation was unnecessary, owing to their uniform distribution and regular current.

25. *Final preparations.*

I come at length to the more interesting part of my narrative. The three days and nights which preceded the event were occupied in adjusting the polar axis, in examining every adjustment that could or could not require it, in exchanging the broad coarse pointer which I had used for night work for a stout but sharp needle, in going over and over again a mental review of the probable appearances and the possible contingencies which might arise. The three months' disuse, too, since I had to give up the

nebulæ, made fresh exercise necessary. Among other things, I concluded not to alter the pendulum, long ago adjusted for sidereal time. The difference of rate being only 1 in 365 for mean time (and 1 in 388 for solar time at that date), the telescope would only gain on the sun by less than one second during the $5\frac{1}{2}$ minutes of totality; so that even supposing I should wish to keep it directed on one and the same point the whole time, the practical effect would only be that that point would move along the slit by perhaps $\frac{1}{20}$ part of its visible length (estimating that length, or the width of the field, at 5′). I mention this as the "Instructions" direct the adjustment to apparent solar time.

### 26. *Disuse of the Barlow Lens accounted for.*

In one other respect, too, I must plead guilty to a departure from the letter of those instructions, which hardly perhaps needs justification; I allude to the disuse of the Barlow lens. My reason was principally this, that its insertion keeps the observer some 6 inches further from the body of the instrument, and, besides involving a complete disturbance of equilibrium, puts him out of reach of the declination screw—results which I could not but think had not been contemplated. I should add that I was quite confident of the practicability of catching a prominence, without having its image doubled in size, though I was by no means so sure that I could spare any of the light, which would be reduced one-fourth.

### 27. *Care in adjusting the Pointer during the approach of the Moon.*

During the advance of the moon, and up to the last available moment, I paid particular attention to the collimation (I use the word in its true sense of *aim*) of the needle-point, being perhaps unnecessarily anxious to avoid my old difficulty of finding my object in the spectroscope. The sharp cusps were well suited to this purpose, and the sun-spots were good tests. I had been fortunate in getting the pointer very exact, and was therefore not troubled with any collimation-error to allow for.

### 28. *Spectrum at the Moon's centre.*

While thus employed I had occasion to remark that at the centre of the moon, some nine or ten minutes before totality, the intensity of the solar spectrum was much about the same as that of the full moon.

### 29. *Measurement of Solar Lines.*

*Intensity of Spectrum of Limb at* D.—The principal solar lines were measured at intervals during the advancing eclipse. A few minutes before totality, in going over these lines for the last time, the slit being as wide as was allowable for full sunlight, *i. e.* very narrow, I recorded an increasing brilliancy in the spectrum in the neighbourhood of D, so great in fact as to prevent any measurement of that line till an opportune cloud moderated the light. I am not prepared to offer any explanation of this. The clouds were

arranged in two distinct strata, the lower one containing masses hurrying past with the monsoon-current at no great height, the upper consisting of light, thinly scattered cirri showing very little motion. It is conceivable that the latter may have been obstinately interposed until the time when I remarked the recorded brilliancy; but I cannot say that I should be satisfied with such an explanation.

*Whiteness of the Crescent.*—I also remarked that the *whiteness* of the crescent, as seen in the finder, was apparently intensified as it grew narrower. Possibly this was the effect of contrast with the darkening background; for at this time I began to be annoyed by the appearance of five or six phantom crescents, which seemed to be trying to rival the legitimate one. I imagine I was indebted to the dark glass for these apparitions; but whatever called them up, they most effectually confused the view of the closing scene; whatever might otherwise have been seen at this stage was swamped in the confusion.

30. *Restlessness during approach of shadow.*

Up to within about ten minutes of totality I was every now and then outside watching progress through one or the other of two smaller telescopes of moderate power, one of which I had borrowed from the chief, who indulges a taste for the possession of English manufactures to an extraordinary degree. I noticed no marked inequalities of surface in the advancing limb, nor any bluntness of the cusps; but I must allow that I was not in a sufficiently composed state of mind to observe critically anything not bearing directly on the special problem before me. I was impressed with a notion that everything must be subordinated, in my case, to the requisite freedom of attention when totality commenced, and was specially anxious to *save my eyesight.* I studiously avoided looking at the sun except under cover of a cloud; and though I had provided the telescopes with graduated smoked glasses, I was nervously afraid to look through them too long or too intently—all which can only be understood by referring to what has been said about the absence of any foreknowledge of the impending revelation. My last view of external appearances showed nothing very striking—a few deeply neutral-tinted patches of sky in the zenith, and an increasing gloominess in all directions, being all the phenomena whose impression has outlived the excitement of the shortlived minutes which ensued. I reentered the observatory, and retired behind my black curtain to watch the event.

31. Gentlemen, I have thus far endeavoured to lay before you, as far as possible, in an orderly manner, an outline of the preliminary arrangements for the employment of your Society's instruments, and a sketch of my proceedings up to the hour of the eclipse. If in so doing I have been unnecessarily tedious, I would ask you to remember that these few pages but faintly represent the months of anxious study and preparation which have passed since I accepted the responsibility involved in the charge of an ex-

pedition deputed by the illustrious body I have now the honour of addressing—a responsibility more engrossing, it may be, but not lessened, by the specific but novel character of the proposed object of the expedition. I proceed now to describe how far that object has been attained; and here I feel that I cannot well indulge in too great a minuteness of detail.

32. *Relative positions of Pointer, Slit, and Sun's Limb.*

The spectroscope may be inserted, and employed with its slit in any direction perpendicular to the optical axis of the telescope. It is therefore competent to the observer to place the slit perpendicular or tangential to the sun's circumference at any point; and there can be no doubt that, were the observations conducted at leisure, it would be desirable to examine the whole circumference in both positions; but the operation of turning the spectroscope is not so very simple a one but that the advantages and disadvantages of any such proceeding require to be well considered where time is of the first importance. I decided on employing the slit in one direction only, that which corresponded with the diurnal motion. It so happened that this corresponded nearly with the direction of the relative motion of the sun and moon, so that the widest part of the crescent could be made to fall nearly perpendicularly across the slit. The needle (in the finder) and its point accurately represented the direction and centre respectively of the slit; therefore, when the needle-point touched the sun's limb at the centre of the crescent, a solar spectrum of definite width appeared in the field, of which one edge (the right-hand) continued stationary, while the other (the left) advanced slowly but perceptibly towards it, the solar spectrum decreasing visibly in width.

33. *Last view of Solar Spectrum.*

About a minute's breadth remained. A few seconds more and it would vanish suddenly. Whatever spectrum the corona could show must then be revealed, unless indeed a "prominence" or "sierra" should happen to be situated at that precise spot, in which case the double spectrum should be presented. The nervous tension at the moment may be conceived: what would be seen? what call for action would be made? and for what action? or, if nothing were seen, what would have to be done? I cannot say that I was prepared, at that moment, either with these questions, or with ready answers to them; but that was the sensation. With regard to the last, I suppose I should have instinctively widened the slit; and had that failed, should then have gone to the finder to look for a prominence. As it was, the spectrum faded out as I looked, while it had still appreciable width, and I knew a cloud had intervened.

*Totality commences unseen.*—A few seconds more and the spectrum of diffuse light vanished also, and told me the eclipse was total, but behind a cloud.

34. *On the watch for a glimpse.*

I went to the finder, removed the dark glass, and waited; how long, I

cannot say; perhaps half a minute. Soon the cloud hurried over; following the moon's direction, and therefore revealing first the upper limb, with its scintillating corona, and then the lower.

*A prominence seen and aimed at.*—Instantly I marked a prominence near the needle-point, an object so conspicuous that I felt there was no need to take any precautions to secure identification. It was a long finger-like projection from the (real) lower left-hand portion of the circumference. A rapid turn of the declination-screw covered it with the needle-point, and in another instant I was at the spectroscope. A single glance and the problem was solved.

*Its Spectrum.*—THREE VIVID LINES, RED, ORANGE, BLUE; NO OTHERS, AND NO TRACE OF A CONTINUOUS SPECTRUM.

35. *Measurement of lines undertaken, with partial success.*

When I say the problem was solved, I am of course using language suited only to the excitement of the moment! It was still very far from solved, and I lost no time in applying myself to measurement. And here I hesitate; for the measurement was not effected with anything like the ease and certainty which ought to have been exhibited. Much may be attributed to haste and unsteadiness of hand, still more to the natural difficulty of measuring intermittent glimpses; but I am bound to confess that these causes were supplemented by a failure less excusable. I have no idea how those five minutes passed so quickly! Clouds were evidently passing continually; for the lines were only visible at intervals—not for one-half the time, certainly—and not always bright; but still I ought to have measured them all. My failure was in insufficient illuminating power; but *why*, I cannot tell. I never experienced any difficulty of the kind with the nebulæ, which required that I should flash in light suddenly over and over again. I had found the hand-lamp the surest way; but it failed me here in great measure. The *red* line must have been less vivid than the *orange*; for after a short attempt to measure it, I passed on to secure the latter.

*Two lines measured.*—In this I succeeded *to my satisfaction*, and accordingly tried for the *blue* line. Here I was not so successful. The glimpses of light were rarer and feebler, the line itself growing shorter and, what remained of it, further from the cross. I did, however, place the cross wires in a position certainly very near the true one, and got a reading before the reillumination of the field told me that the sun had reappeared on the other limb. These readings were called out, as those of the solar lines had been, to my recorder; and it was only afterwards that I compared them.

I need not dwell on the feelings of distress and disappointment which I experienced on realizing the fact that the long-anticipated opportunity was gone, and, as it seemed to me then, *wasted*. I seemed to have failed entirely. Almost mechanically I directed the telescope to the bright limb, to verify the readings of the solar lines; and in so doing my interest was

again awakened by the near coincidence, as it seemed, of the line F with the position of the wires; but a little reflection convinced me that the distance of the former was greater than the error which I might have made in intersecting the blue line.

*Their readings and those of the solar lines.*—I read F, and then D & C. The following were my readings up and down :—

| | C. | D. | *b.* | F. |
|---|---|---|---|---|
| Before .... | 1·91 | 2·96 | 4·58 | 5·64 |
| | 1·90 | 2·94 | 4·56 | 5·61 |
| | 1·93 | 2·98 | 4·60 | 5·65 |
| | 1·92 | 2·97 | 4·58 | 5·62 |
| Bright lines | ... | [3·00] | ... | [5·56] |
| After..... | 1·93 | 3·00 | ... | 5·65 |

36. *Identity of the Orange Line.*

I consider that there can be no question that the ORANGE LINE was identical with D, so far as the capacity of the instrument to establish any such identity is concerned.

37. *Of the Blue Line : doubtful.*

I also consider that the identity of the BLUE line with F is not established ; on the contrary, I believe that the former is less refracted than F, but not much.

38. *Of the Red Line : uncertain.*

With regard to the RED line, I hesitate very much in assigning an approximate place: B and C represent the limits ; it might have been near C ; I doubt its being so far as B ; I am not prepared to hazard any more definite opinion about it. Its colour was a *bright* red. This estimate of its place is absolutely free from any reference to the origin of the lines C and F.

39. *Subsequent mental aberration : not unusual.*

It is a fact not unworthy of notice that in all the accounts of eclipses, written soon after the event, which I have read, the record hurries rapidly to a close after the sun has reappeared ; the reason, no doubt, is that a reaction takes place after the excitement of witnessing the actual eclipse, and phenomena which might be noticed after, quite as well as before, pass unregarded on that account. For my part I was surprised to find how utterly indifferent I felt to the appearance of things when I came out of my observatory. I am almost ashamed to confess that I went straight to my tent, and tried to write down what I *had* seen, instead of going to the telescope to watch for what still might be seen. It never even occurred to me to remove the spectroscope and use the fine telescope I had at command.

40. *Afterconsideration of the phenomena witnessed.*

I have not quite exhausted the statement of my observations, though

what I have still to state was rather the result of subsequent reflection than of actual cognizance at the time. I said that the prominence was situated close to the needle-point. I estimate its position as at the east point, a few degrees to the left of the lowest, of the sun's limb. Its form was that of a projecting *finger* slightly curved to the southward, and its height nearly 2′. The slit was at right angles to the hour-circle, and therefore perpendicular to the sun's limb at this point. A vertical section (so to speak) of the prominence was therefore admitted through the slit. It appears, then, that the length of the lines corresponded with the height of the prominence, being limited (as in the case of the spectrum of the section of the crescent) on the one hand (the left) by the advancing moon's limb at the centre of the field, and on the other by the natural summit of the prominence, or flame, as we are now entitled to call it.

*Spectrum of Corona not seen.*—Beyond this summit the light of the corona was free to enter; it was also free to enter *with* that of the flame; but I saw the spectrum of the latter *only*. I thence conclude that the spectrum of the corona was a faint solar one,—a conclusion quite in accordance with the other characteristics of this phenomenon, such as the radiated appearance and the evidence from polarity, indicating a central source of light. With regard to the latter, it is clear that the light of the corona is polarized in planes passing through the sun's centre (as the gist of Lieut. Campbell's Report), and therefore that the corona shines mainly by reflected light. At the same time it is possible that the absence of a spectrum of the corona at this particular spot may have been accidental. I have since heard that the corona was particularly feeble at this point. I had no opportunity of studying the corona myself. After first catching sight of the eclipse in the finder, I never left the spectroscope but once, when a long interval of cloudiness sent me to the finder to make sure. I then caught a few seconds' glimpse again, and remarked a red blot (I recognized no shape) of a prominence at about the north point, or rather to the west of it.

41. *Remarks on the ease with which the lines might be measured, and suggestions for future observations.*

I have now a few remarks to add which may be of use to future observers, if not of any present value. It is difficult to say what might or might not have been done but for the clouds; but I am pretty certain that (even labouring, as I was, under the difficulty of bad illumination) not only might all three lines have been satisfactorily measured, but time would have sufficed for further examination. The course which that examination should take is a question which it is of the highest importance for an observer to decide on previously. I believe I was right in using a narrow slit to begin with, *not anticipating such a totally dark field*; but I should not do so again; or if I did, with the object of getting exact measures of the three principal lines, I should be prepared to widen the slit

to look for faint ones, the positions of which I should *estimate* with reference to those three. I should then direct the telescope at the brightest part of the corona, taking very good care to *prefer* a part free from any appearance of sierra, and if possible near the east or west points, so that the slit might admit a vertical section. Assuming that the corona does not emit *tosochromatic* light —if I may be allowed to coin a word to indicate definite but unspecified colours, both in respect of number and tint (or pitch)—of very distinct character, the spectrum of such a vertical slice *might* indicate by its varying *width* that the light was not uniformly constituted. Another point to be ascertained is whether all flames are constituted alike. This would require a more or less rapid glance at the spectra of several. I have spoken of "the three principal lines" because *I* saw no others. I have, however, heard rumours of a greater number having been seen by other observers, whether of equal brilliancy or not I do not know; but it inclines me to enforce the statement I have already made of "three vivid lines—no more," as seen with a narrow slit. I had no suspicion whatever of the presence of any but those three; and as I first saw them they were as sharp and bright as one could well wish to see. Whether the prominence which I looked at was the same as those in which more than three lines were seen I do not know.

42. *Lieut. Campbell's Observations satisfactory in their result.*

The determination of the polarization-plane of the corona is as satisfactory as can be desired, and Lieut. Campbell's account is so clear that I have little to say about it. It is to be regretted that he did not see the effect of polarization *all round* at the same time, with a power low enough to include the whole of the phenomena; but the view fortunately obtained with the higher power remedies this in great measure by showing what *would* have been seen at points 90° distant from that which he describes.

43. *Results with Hand Spectroscopes unknown.*

With regard to the hand spectroscopes I have scarcely any report to make. Lieut. Campbell had no opportunity. Capt. Haig has sent no report. Neither have I heard anything of one of the two sent to sea. The only record I have received is that of Capt. Rennoldson, of the 'Rangoon,' P. & O. Co.'s Steam Ship, which I enclose. He mentions having seen with the spectroscope a prominence not seen by others with (I presume) ships' glasses of greater power. This is difficult to understand, except on the supposition that the light of the corona was weakened by dispersion, while that of the flame was not, or not in so great a degree. Should it turn out that the prominence he describes was a reality, it is barely possible that the above explanation may be the true one; in which case it suggests the possibility of seeing the prominences with a heavy battery of prisms when the sun is *not* eclipsed, especially if they are made of yellow glass; nay, even of seeing them, without the help of dispersion, through a medium calculated to stop all light but that of the sodium flame.

44. *Mr. Chambers prevented by Clouds from using two other Spectroscopes.*

Two other hand spectroscopes in my possession were lent to Mr. Chambers, Government Astronomer at Bombay, who stationed himself not far from Bégápúr; but I am sorry to say he was denied the opportunity of using them by the clouds.

Gentlemen, I beg to apologize for the length of my narrative, and to subscribe myself, with much respect,

Your obedient Servant,

J. Herschel, Lieut. R.E.

Bangalore, Sept. 1868.

## LIEUT. CAMPBELL'S REPORT.

"I was deputed to accompany Lieut. Herschel on his expedition to observe the phenomena of the total eclipse, and to use the instruments supplied by the Royal Society for the observation of polarized light in the corona and red flames.

"The instruments in question were as follows:—A telescope of 3-inch aperture, mounted on a rough double axis, admitting of motion in azimuth and altitude by hand only, unaided by any appliance for clamping and slow motion. The telescope was provided with three eyepieces of magnifying-powers 27, 41, and 98; and with it were furnished two analyzers for polarized light, viz. a double-image prism and a 'Savart's polariscope.'

"The first gives two images of the object viewed, which, when polarized light is present, become strongly coloured with complementary tints, by whose changes, according to the position in azimuth of the analyzer, the plane of polarization may be found.

"The second shows the presence of polarized light by the formation, across the image of the object viewed, of coloured bands, which alter in arrangement and intensity according to the position of the polariscope with reference to the plane of polarization, and hence afford a means of arriving at a knowledge of the latter.

"With the former, slight polarization would probably be more readily recognized at a glance; while with the latter the plane of polarization could be more easily and accurately determined.

"To carry these arms I had a pair of jointed arms constructed, so attached by a collar and screw to the eye-tube of the telescope as to admit of the eyepiece being changed. Each arm carried one of the analyzers in a cell, in which a rotatory motion could be given for analyzing purposes.

"Either analyzer could in this way be brought instantly into position before the eyepiece of the telescope, or both could be turned aside and the telescope used by itself at pleasure.

"Immediately behind the apparatus a circular piece of cardboard of about 12 inches diameter and neatly graduated was firmly attached to the eye-tube, and to each analyzer was affixed a long pointer by which its

azimuth could be referred to the graduations on the card circle, should measures of position or change of azimuth appear desirable.

"I was also furnished with a hand spectroscope for direct vision.

"The point chosen for my station was on the northern slope of a low range of hills, about $1\frac{1}{2}$ mile W. by S. of Jamkandi. The flatness of the hills on top offered no point from which an uninterrupted view could be obtained in all directions; and from my station I only had a view of the northern half of the distant horizon over the plains extending in that direction for many miles, above the level of which I was raised about 200 feet,

"Early on the morning of the 18th I proceeded to the spot, having previously sent up the instruments and a tent for shelter in case of necessity.

"At sunrise the sky was beautifully clear, except in the northern horizon, where there were low clouds lying over the river Kistna. There was a gentle breeze from S.W. by W. A little later light flocculent clouds began to rise and form in an arch overhead from west to east, continuing to increase as the morning wore on; then a light scud set in, and turned gradually into broken masses of thick dark clouds.

"Before the commencement of the eclipse I took observations for time with a small theodolite, from which I computed the error of my chronometer (a mean time one by M'Cabe) to be $1^h\ 14^m\ 55^s{\cdot}5$ *fast* on local apparent time; and by that quantity I have accordingly corrected all observed chronometer times in the statements of time which follow.

"I observed the first contact, which took place at $7^h\ 45^m\ 13^s$ (local apparent time), about 15° from the vertex; after which I watched the progress of the eclipse, and noted the times of occultation of three sun-spots. No. 1 was a large double ragged spot, No. 2 a small well-defined one, No. 3 also double, but not so large or distinct as No. 1. After totality I saw a fourth spot very near the sun's limb.

"During the progress of the eclipse I observed no unevenness in the moon's limb, nor any want of sharpness in the cusps, using magnifying-power 27.

"The following notes were taken on the spot:—

At first contact. Sun very slightly obscured by clouds.

At $8^h\ 0^m$. Clouds thick, and gathering from S.W. and W. Wind higher and gusty.

At $8^h\ 10^m$. Clouds overhead, increasing and thickening and rising steadily from west.

At $8^h\ 20^m$. Sky nearly entirely overcast; clouds thickest in neighbourhood of sun.

At $8^h\ 25^m$. A clear break.

At $8^h\ 30^m$. I thought I could discern very faintly the dark limb of the moon beyond that of the sun; and at this time, making allowance for the general cloudiness, I did not perceive any decrease of light on the landscape.

At $8^h\ 40^m$. But ten minutes later the darkness was decided.

At $8^h\ 45^m$. Thick clouds well broken up, still gathered most closely in the region of the sun. Light becoming lurid, and increase of darkness very apparent.

At $8^h\ 52^m$. Cusps perfect (magnifying-power 27).

"Closely before totality a bright line of light appeared to shoot out at a tangent to the moon's limb at its centre, as if running across the bright crescent of the sun (though of course not visible against the superior light) and extended beyond each cusp to a distance nearly, if not quite, 15'. [Note by Lieut. H. The sketch in the margin represents Lieut. Campbell's meaning, as ascertained orally.] The corona became visible immediately after, between the dark limb of the moon and the bright line. The corona did not appear so bright as the line, the brilliance and whiteness of the light of which was most striking. This was seen through a highly smoked glass. At this period, probably not more than 3 to 5 seconds before totality ensued, a thick cloud shut out everything, and the rest of the phenomenon was only seen fitfully through openings in the clouds, for an aggregate period which I estimate at somewhat less than half that of totality.

"This alternate appearance and disappearance troubled me greatly, and gave rise to nervousness and excitement; for owing to the imperfect mounting of my telescope I was apt to lose my place whenever the light was cut off by clouds, and to waste the precious moments of clearness in finding it again.

"On the first opportunity after the commencement of the eclipse I turned on the double-image prism with the eyepiece of 27 magnifying-power, as recommended in the Instructions, which gave a field of about 45' diameter. A most decided difference of colour was at once apparent between the two images of the corona; but I could not make certain of any such difference in the case of a remarkable horn-like protuberance, of a bright-red colour, situated about 210 degrees from the vertex, reckoned (as I have done in all cases) with reference to the actual, not the inverted image, and with direct motion. I then removed the double-image prism and applied the Savart's polariscope, which gave bands at right angles to a tangent to the limb, distinct but not bright, and with little, if any, appearance of colour. On turning the polariscope in its cell the bands, instead of appearing to revolve on their own centre, passing through various phases of brightness, arrangement, &c., travelled bodily along the limb, always at right angles thereto, and without much change in intensity, or any at all in arrangement.

"The point at which they seemed strongest was about 140° from the vertex, and I recorded them as black centred.

"Believing that with a higher power and a smaller field I should find it easier to fix my attention on one point of the corona and observe the phases

of the bands at that point, I changed eyepieces applying that of 41 power. With this eyepiece the first clear instant showed the bands much brighter than before, coloured, and as tangents to the limb at a point about 200° from the vertex; but before I could determine anything further a cloud shut out the view, and a few seconds later a sudden rush of light told that the totality was over, though it was difficult to believe that five minutes had flown by since its commencement.

"I experienced a strong feeling of disappointment and want of success; the only points on which I can speak with any confidence being as follows:—(1) When using the double-image prism, the strong difference of colour of the two images of the corona, and the absence of such difference in the case of the most prominent red flame. (2) With the 'Savart's polariscope' the bands from the corona were decided; with a low power they were wanting in intensity and colour; excepting alternate black and white, making it difficult to specify the nature of the centre; and their position was at right angles to the limb, extending over about 30° of the circumference. When the polariscope was turned the bands travelled bodily round the limb without other change in position or arrangement, as if indeed they were revolving round the centre of the sun as an axis. With a higher power, when a smaller portion of the corona was embraced, the bands were brighter, coloured, and seen in a different position, viz. tangents to the limb.

"The appearance observed with a low power seems exactly what might be expected, supposing the bands to be brightest at every point when at right angles to the limb, in which case the bands growing into brightness at each succeeding point of the limb would distract attention from those fading away at the points passed over as the analyzer revolved.

"After totality was over the clouds cleared away somewhat, and I watched the eclipse till its conclusion, noting the times of emersion of the spots and of last contact.

"A light shower fell at 9.30.

"During totality several stars and planets were seen by those who were with me; and a fowl which I had placed near me, out of curiosity, was observed to compose itself to sleep. It was at no time so dark as I had expected: after the total phase had commenced I read the chronometer and wrote notes in pencil without difficulty; and the light of a bull's-eye lantern when thrown on my paper appeared somewhat dull.

"The brilliance of the light of the corona when it burst out through the openings in the clouds astonished me. Also the very gradual decrease of light before totality, and the wonderful flood of light which followed the instant of the sun's reappearance (though behind a cloud) were very striking.

"I was too much occupied in watching the position of the sun, so as not to lose an instant of the precious intervals of clearness, to see much of the general effect. I had no opportunity of using the hand spectroscope.

There was no one in my neighbourhood (except those of my own party, who had been warned to keep silence), but when totality commenced a wailing shout was heard in the distance, apparently rising all round us, which was succeeded after a few seconds by silence.

"The distant features of the landscape disappeared, and I noticed one light (apparently a village fire) some miles distant.

"I give below the different times I observed as of possible interest. Local apparent time is used :—

| | First contact. | Last contact. |
|---|---|---|
| | h m s | h m s |
| Sun and moon..... | 7 45 13 | 10 21 59 |
| Spot No. 1..... | 7 57 39 | 9 7 5 |
| Entire disappearance .... | 7 59 5 | |
| Spot No. 2..... | 8 40 28 | 9 54 39 |
| Spot No. 3..... | 8 46 58 | 10 3 25 |

I cannot state with any approach to accuracy either the instant of commencement or [that of] termination of totality."

| | |
|---|---|
| Latitude of station ..... | 16° 30′ 10″ |
| Longitude „ ..... | 75 20 |

(Signed) "W. R. Campbell, Lieut. R.E."

"Bangalore, August 31, 1868."

True copy.

J. Herschel, Lieut. R.E.

Bangalore, September 15, 1868.

(Copy.)

No. 886.

*From J. Geogheyan, Esq., Under Secretary to Government of India.*

*To The Superintendent of the Great Trigonometrical Survey of India.*

Fort William, February 21, 1868.

Sir,—I am directed to acknowledge receipt of your letter No. $\frac{6}{98}$ of 4th instant; requesting permission to employ certain officers of the Government Trigonometrical Survey in taking observations of the total solar eclipse of the 17th, 18th August, and asking sanction to the expenditure on this account estimated roughly not to exceed 2000 Rupees.

In reply, I am directed to state that the Governor-General in Council cordially approves of your proposed arrangements, and sanctions the necessary expenditure.

The Government of India, I am to state, will be prepared to do every-

thing in its power towards securing full and accurate observations on this rare and important occasion.

I have, &c.,

(Signed) J. GEOGHEGAN,

*Under Secretary to Government of India.*

True copy.

J. HERSCHEL, Lieut. R.E.

[Commander Rennoldson's letter, which was sent independently by the Secretary of the Peninsular and Oriental Steam Navigation Company appears below.]

*XI. "Observations of the Total Solar Eclipse of August 18, 1868." By Captain CHARLES G. PERRINS. Communicated by Prof. STOKES. Received October 30, 1868.

(Abstract.)

These observations are contained in a letter dated "S.S. 'Carnatic,' Suez, 28th August, 1868," addressed to the Managing Directors, Peninsular and Oriental Steam Navigation Company. One of the hand spectroscopes sent out by the Royal Society had been entrusted to Captain Perrins; but as his ship at the time of the eclipse was about 20 miles north of the track of the total phase, he had no opportunity of using it for the observations contemplated. He thus describes the appearance at the time of greatest obscuration:—

"That portion of the sun remaining uneclipsed consisted of a narrow streak (in shape like a crescent) of its upper left limb, in size about $\frac{1}{16}$ part of its diameter. The light emitted from this was of a very peculiar description and difficult to describe, being at the same time extremely brilliant and yet most remarkably pale. The high sea running appeared like huge waves of liquid lead, and the ghastly paleness of the light thrown upon it and all around revealed a scene which, for its weird-like effect, it would be as impossible to depict as it is to describe."

The slender crescent showed in the spectroscope several dark lines, as was to be expected.

XII. "Observations of the Total Solar Eclipse of August 18, 1868." By Captain D. RENNOLDSON. Communicated by Prof. STOKES. Received October 30, 1868.

(Copy.)

*From Captain D. Rennoldson.*

"Peninsular and Oriental Company,
Bombay, 22nd August 1868.

"DEAR SIR,—I enclose you a sketch of the eclipse seen on board the

* This and the following three communications were transmitted by the Directors of the Peninsular and Oriental Steam Navigation Company.